

# THE MERCK INDEX

AN ENCYCLOPEDIA OF  
CHEMICALS, DRUGS, AND BIOLOGICALS

THIRTEENTH EDITION

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*Published by  
Merck Research Laboratories  
Division of*

**MERCK & CO., INC.**  
Whitehouse Station, NJ

2001

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**MERCK & CO., INC.**

Whitehouse Station, NJ

USA

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1st Edition—1889  
2nd Edition—1896  
3rd Edition—1907  
4th Edition—1930  
5th Edition—1940  
6th Edition—1952  
7th Edition—1960  
8th Edition—1968  
9th Edition—1976  
10th Edition—1983  
11th Edition—1989  
12th Edition—1996

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Library of Congress Catalog

Card Number 89-60001

ISBN Number 0911910-13-1

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Printed in the USA

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ral acids. Aq  
-70°; reduced

mpn.

5-1] Cobalto-  
s.  $\text{Co}_3\text{O}_4$ ; mol  
elin's, *Cobalt*  
ent, 202, 491-  
3-13; 16, 3-15

stem. d 6.11.  
out 71% Co.  
t lower temps  
but no definite  
Co metal by C,  
ds, alkalies.  
ing wheels.

Cobalt trifluo-  
%. Prepn from  
3. *Syn.* 3, 175  
*organic Chem-*  
New York, 2nd  
, Kukul, *J. Am.*

1.88. Discolors  
water giving off  
uorine pressure  
in an  $\text{F}_2$  stream  
ed glass, quartz.

ly for complete  
cess.

2016-80-7] Co-  
ho $\text{H}_2\text{O}$ ; mol wt  
(OH). Alternate  
*book of Prepar-*  
Ed. (Academic  
1; Schrader, Per-  
7). Existence of  
established: Pa-  
Nicholls in *Com-*  
Bailar, Jr. et al.  
See also de Bie,  
der, Petzold, loc.  
(1969).  
crystal structure.  
a vacuum. Prac-  
 $\text{Cl}_2$ ; sol in  $\text{HNO}_3$ .

obalt from nickel.

782-01-9] Hexa-  
tassium hexani-  
tassium nitroco-  
C.I. Pigment Yel-  
2.26. Co 13.03%.  
 $(\text{O}_2)_6$ . Incorrectly  
of  $\text{KNO}_3$  to a so-  
m. 32, 548 (1962).  
c crystals. Very  
ly insol in alcohol.

n painting on glass  
on of Co from Ni:

$2\text{H}_4\text{CoO}_4$ ; mol wt  
36.15%.  $\text{Co}(\text{C}_2\text{H}_3\text{O}_2)_2$   
dioxide or carbon-  
al in *Kirk-Othmer*  
(Interscience, New  
dered Co and acetic  
prepn by oxidation  
acid: Gwynn et al.

US 3246024 (1966 to Gulf). Review: de Bie, Doyen, *Cobalt*  
15, 3-13; 16, 3-15 (1962).

Light-pink crystals. Readily sol in water.

**Tetrahydrate.** Bis(acetato)tetraaquocobalt. Intense red, mono-  
clinic, prismatic crystals. d 1.705. On heating becomes anhy-  
drous by 140°. Sol in water, alcohols, dil acids, pentyl acetate.  
pH of 0.2 molar aq soln 6.8.

USE: Bleaching agent and drier for lacquers, varnishes; in  
anodizing; catalyst for oxidation and esterification; foam stabili-  
zer for malt beverages.

**2459. Cobaltous Arsenate.** [7785-24-2] C.I. 77350.  
 $\text{As}_2\text{Co}_3\text{O}_8$ ; mol wt 454.64. As 32.96%, Co 38.89%, O 28.15%.  
 $\text{Co}_3(\text{AsO}_4)_2$ . Octahydrate occurs in nature as *erythrite* or *cobalt*  
*bloom*. Prepn: *Gmelin's, Cobalt* (8th ed.) 58, (part A), 305  
(1932) and supplement, 752 (1961); Charles-Messance et al.,  
*Bull. Soc. Chim. France* 1962, 574. See *Colour Index* vol. 4  
(3rd ed., 1971) p 4664.

Octahydrate, pink to blood-red, monoclinic, fine needles. On  
heating becomes anhydr by 400°. Dec by 1000° to  $\text{Co}_6\text{As}_2\text{O}_{11}$ .  
d 2.9-3.1. Practically insol in water. Sol in dil mineral acids,  
in  $\text{NH}_4\text{OH}$ .

USE: Painting on glass and porcelain.

**2460. Cobaltous Bromide.** [7789-43-7] Cobalt dibro-  
mide.  $\text{Br}_2\text{Co}$ ; mol wt 218.74. Br 73.06%, Co 26.94%.  $\text{CoBr}_2$ .  
Prepn of hexahydrate from  $\text{CoCO}_3$  and  $\text{HBr}$ : Clark, Buchner,  
*J. Am. Chem. Soc.* 44, 230 (1922). Prepn of anhydr: *idem*, loc.  
cit.; Watt et al., *ibid.* 77, 2752 (1955); Wydeven, Gregory, *J.*  
*Phys. Chem.* 68, 3249 (1964).

Bright green solid or lustrous green cryst leaflets. mp 678°  
(under  $\text{HBr}$  and  $\text{N}_2$ );  $d_4^{25}$  4.909. Hygroscopic, forms hexahy-  
drate in air. Readily sol in water, methanol, ethanol, acetone,  
methyl acetate.

**Hexahydrate.** Red to reddish-purple, deliquesce, prismatic  
crystals. mp 47-48°.  $d_4^{25}$  2.46. Loses  $4\text{H}_2\text{O}$  at 100° giving the  
purple dihydrate, and all  $\text{H}_2\text{O}$  by 130°. Sol in water giving red  
or blue soln depending on concn and temp, in methanol giving  
red soln, in ethanol, acetone, ether, methyl acetate giving blue  
solns. Keep well closed.

USE: Chiefly in hygrometers; also in catalysts for organic  
reactions.

**2461. Cobaltous Carbonate.** [513-79-1]  $\text{CCoO}_3$ ; mol wt  
118.94. C 10.10%, Co 49.55%, O 40.35%.  $\text{CoCO}_3$ . Occurs in  
nature as the mineral *cobalt spar* or *sphaerocobaltite*. Prepd by  
heating a soln of a cobaltous salt with  $\text{Na}_2\text{CO}_3$ : Schlessinger,  
*Inorg. Syn.* 6, 189 (1963) where it is the starting material for the  
prepn of trinitrotriamiccobalt. Review: de Bie, Doyen, *Co-*  
*balt* 15, 3-13; 16, 3-15 (1962).

Red powder or rhombohedral crystals. d 4.13. Almost insol  
in water, alcohol, methyl acetate. Does not react with cold  
concd  $\text{HNO}_3$  or  $\text{HCl}$ ; when heated, dissolves with evolution of  
 $\text{CO}_2$ . Oxidized by air or weak oxidizing agents to cobaltic car-  
bonate.

**Hexahydrate.** Pink to violet-red cryst needles. Pptd when  
excess  $\text{CO}_2$  is present during prepn. On heating becomes anhydr  
by 140°. Stable in air.

**Cobaltous carbonate basic.** Cobalt carbonate hydroxide.  
 $\text{C}_2\text{H}_6\text{Co}_3\text{O}_{12}$ ; mol wt 516.73.  $\text{Co}_3(\text{OH})_6(\text{CO}_3)_2$ . Pale-red pow-  
der, usually containing some water. Practically insol in water;  
sol in dilute acids and ammonia.

USE: In ceramics; manuf of Co pigments; prepn of Co  
comps.

THERAP CAT (VET): Nutritional factor. Used in cobalt defi-  
ciency in ruminants.

**2462. Cobaltous Chloride.** [7646-79-9] Cobalt dichlo-  
ride.  $\text{Cl}_2\text{Co}$ ; mol wt 129.84. Cl 54.61%, Co 45.39%.  $\text{CoCl}_2$ .  
Prepn of anhydr from Co powder and  $\text{Cl}_2$ : Osthoff, West, *J.*  
*Am. Chem. Soc.* 76, 4732 (1954); from the acetate and acetyl  
chloride: Watt et al., *ibid.* 77, 2752 (1955); by dehydration of  
the hexahydrate with  $\text{SOCl}_2$ : Hecht, *Z. Anorg. Chem.* 254, 51  
(1947); prepn of the hexahydrate by treating an aqueous soln of  
a cobaltous salt with  $\text{HCl}$ : *Cobalt—Its Chemistry, Metallurgy,*  
*and Uses*; R. S. Young, Ed., A.C.S. Monograph Series no. 149  
(Reinhold, New York, 1960) p 76. Review: de Bie, Doyen,

*Cobalt* 15, 3-13; 16, 3-15 (1962). Toxicity studies: G. J. A.  
Speijers et al., *Food Chem. Toxicol.* 20, 311 (1982); P. P. Singh,  
A. Y. Junnarkar, *Indian J. Pharmacol.* 23, 153 (1991). Review  
of toxicology: B. Venugopal, T. D. Luckey, *Environ. Qual.*  
*Safety Suppl.* 1, 4-73 (1975).

Pale-blue hygroscopic leaflets; colorless in very thin layers;  
turns pink on exposure to moist air. mp 735°; bp 1049°;  $d_4^{25}$   
3.367. Dec 400° on long heating in air. Sublimes at 500° in  
 $\text{HCl}$  gas, forming iridescent, fluffy, colorless cryst. Sol in water,  
alcohols, acetone, ether, glycerol, pyridine.  $\text{LD}_{50}$  in mice, rats  
(mg/kg): 360.0, 171.0 orally; 92.6, 36.9 i.p.; 23.3, 4.3 i.v.  
(Singh, Junnarkar).

**Hexahydrate.** [7791-13-1] Monoclinic crystals. Structure  
is reported to be  $[\text{CoCl}_2(\text{H}_2\text{O})_4] \cdot 2\text{H}_2\text{O}$ : Mizuno et al., *J. Phys.*  
*Soc. Japan* 14, 383 (1959), C.A. 53, 14630i (1959). Pink to red,  
slightly deliquesce, monoclinic, prismatic crystals. mp 87°;  $d_4^{20}$   
1.924. On heating loses  $4\text{H}_2\text{O}$  at 52-56° forming the dihydrate,  
violet or blue crystals,  $d_4^{25}$  2.477, stable unless exposed directly  
to moisture. Loses another  $\text{H}_2\text{O}$  by 100°, giving monohydrate,  
violet, hygroscopic, amorphous solid or needles. Remaining  
 $\text{H}_2\text{O}$  lost at 120-140°. Sol in water, alcohols, acetone, ether,  
glycerol. pH of 0.2 molar aq soln 4.6. The aq soln is pink to  
red, but turns blue when heated or when  $\text{HCl}$  or  $\text{H}_2\text{SO}_4$  is added.  
Keep well closed.  $\text{LD}_{50}$  orally in rats: 766 mg/kg (Speijers).

Caution: Large amounts of  $\text{CoCl}_2$  depress erythrocyte pro-  
duction. May lead to death in children. Other effects include  
cutaneous flushing, chest pains, dermatitides, tinnitus, nausea  
and vomiting, nerve deafness, thyroid hyperplasia, myxedema,  
congestive heart failure. See E. Beutler et al., *Clinical Disorders*  
*of Iron Metabolism* (Grune & Stratton, New York, 1963) pp  
175-178.

USE: Invisible ink; humidity and water indicator; in  
hygrometers; temp indicator in grinding; in electroplating; for  
painting on glass and porcelain; prepn of catalysts; fertilizer and  
feed additive; foam stabilizer in beer; as absorbent for military  
poison gas and ammonia; in manuf of vitamin  $\text{B}_{12}$ . Radioactive  
cobalt chloride,  $^{57}\text{CoCl}_2$  (half-life 271.79 days, pure gamma  
emitter) used in Mössbauer effect (nuclear clock).

THERAP CAT: Hematinic.

THERAP CAT (VET): Nutritional factor. Used in cobalt defi-  
ciency in ruminants.

**2463. Cobaltous Chromate(III).** [13455-25-9] Cobalt  
chromite.  $\text{CoCr}_2\text{O}_4$ ; mol wt 226.92. Co 25.97%, Cr 45.83%, O  
28.20%. Prepn: *Gmelin's, Cobalt* (8th ed.) 58, (part A), 479  
(1932) and supplement, 874-876 (1961).

Brilliant greenish-blue powder having a cubic spinel structure.  
Almost insol in concd  $\text{HCl}$  and  $\text{HNO}_3$ .

USE: Green pigment for ceramics.

**2464. Cobaltous Cyanide.** [542-84-7] Cobalt cyanide.  
 $\text{C}_6\text{CoN}_2$ ; mol wt 110.97. C 21.65%, Co 53.11%, N 25.24%.  
Prepn: Ray, Sahu, *J. Indian Chem. Soc.* 23, 161 (1946); *Gme-*  
*lin's, Cobalt* (8th ed.) 58, (part A), 364 (1932) and supplement,  
712 (1961). Structure reported as  $\text{Co}_3[\text{Co}(\text{CN})_6]_2$ : P. S. Pos-  
kozim et al., *J. Inorg. Nucl. Chem.* 35, 687 (1973). Prepn and  
structure as  $\text{Co}(\text{CN})_2$ : D. M. S. Mosha, D. Nicholls, *Inorg.*  
*Chim. Acta* 38, 127 (1980).

Deep-blue, very hygroscopic powder.  $d_4^{25}$  1.872.

**Di- to trihydrate.** Pink to reddish-brown powder or needles.  
Practically insol in water, acids, methyl acetate; sol in alkali  
cyanide solns.

USE: In cobalt catalysts.

**2465. Cobaltous Fluoride.** [10026-17-2] Cobalt difluo-  
ride.  $\text{CoF}_2$ ; mol wt 96.93. Co 60.80%, F 39.20%. Prepd by the  
action of  $\text{HF}$  on anhydr  $\text{CoCl}_2$ : Kwasnik in *Handbook of Pre-*  
*parative Inorganic Chemistry*, vol. 1, G. Brauer, Ed. (Academic  
Press, New York, 2nd ed., 1963) p 267; on  $\text{CoCO}_3$ : Clark,  
Buchner, *J. Am. Chem. Soc.* 44, 230 (1922); on Co: Muetterties,  
Castle, *J. Inorg. Nucl. Chem.* 18, 148 (1961).

Rosy-red tetragonal crystals. mp 1100-1200°, forming a red  
liq. Volatilizes at about 1400°. d 4.43. Sparingly sol in water;  
readily sol in warm mineral acids. Forms di-, tri-, and tetrahy-  
drates, all sol in water; their aq solns are dec by boiling, forming  
the oxyfluoride  $\text{CoF}_2 \cdot \text{CoO} \cdot \text{H}_2\text{O}$ .

USE: Catalyst for organic reactions.

**Note:** This substance is reasonably anticipated to be a human carcinogen: *Ninth Report on Carcinogens* (PB2000-107509, 2000) p III-155.

**USE:** Catalyst; mordant for textiles.

**6525. Nickel Acetylacetonate.** [3264-82-2] Bis(2,4-pentanedionato-*O,O'*)nickel; bisacetylacetonatonickel(II); bis(2,4-pentanediono)nickel(II); 2,4-pentanedione nickel complex.  $C_{10}H_{14}NiO_4$ ; mol wt 256.91. C 46.75%, H 5.49%, Ni 22.85%, O 24.91%.  $Ni(CH_3COCHCOCH_3)_2$ . Also  $Ni(acac)_2$  or  $Ni(AA)_2$ . Prepn from acetylacetone and  $Ni(OH)_2$ : Gash, *Monatsh.* **21**, 103 (1900); from acetylacetone and  $NiCl_2 \cdot 6H_2O$ : Charles, Pawlikowski, *J. Phys. Chem.* **62**, 440 (1958); from 4-diethylamino-3-pentene-2-one and  $NiCl_2 \cdot 6H_2O$ : Gash, *Can. J. Chem.* **45**, 2109 (1967). See also Fernelius, Bryant, *Inorg. Syn.* **5**, 105 (1957). Exists as a trimer in the solid state: Bullen, *Nature* **177**, 537 (1956); Bullen *et al.*, *Inorg. Chem.* **4**, 456 (1965); as a monomer in the vapor phase: Fackler *et al.*, *J. Phys. Chem.* **72**, 4631 (1972). Structure of dihydrate: Montgomery, Lingafelter, *Acta Cryst.* **17**, 1481 (1964).

Emerald-green orthorhombic crystals. mp 229-230°. bp<sub>11</sub> 220-235°.  $d^{17}_4$  1.455. uv max ( $10^{-4}M$  in  $CHCl_3$ ): 298, 265 nm ( $\log \epsilon$  4.34, 4.44). Sol in water, alcohol, chloroform, benzene. Insol in ether, ligroin.

**USE:** Catalyst.

**6526. Nickel Bromide.** [13462-88-9] Nickel dibromide.  $Br_2Ni$ ; mol wt 218.50. Br 73.14%, Ni 26.86%.  $NiBr_2$ .

**Trihydrate.** Yellowish-green, very deliquescent crystals; loses its water at about 200°, the anhydr salt is a golden-yellow color and sublimable in absence of air. Sol in one part water, in alcohol. *Keep well closed.*

**6527. Nickel Carbonate Hydroxide.** [12607-70-4]  $CH_4Ni_3O_7$ ; mol wt 304.12. C 3.95%, H 1.33%, Ni 57.90%, O 36.83%.  $NiCO_3 \cdot 2Ni(OH)_2$ . Tetrahydrate occurs in nature as the mineral *zaraitite*.

**Tetrahydrate.** Green, odorless powder. Insol in water. Sol in ammonia and in dil acids with effervescence.

**USE:** Nickel-plating; catalyst for hardening of fats; in ceramic colors and glazes.

**6528. Nickel Carbonyl.** [13463-39-3] Nickel tetracarbonyl.  $C_4NiO_4$ ; mol wt 170.73. C 28.14%, Ni 34.38%, O 37.48%.  $Ni(CO)_4$ . Intermediate in nickel refining. Made by passing carbon monoxide over finely divided nickel: Mond *et al.*, *J. Chem. Soc.* **57**, 749 (1890); Gilliland, Blanchard, *Inorg. Syn.* **2**, 234 (1946). Use of nickel carbonyl in organic synthesis: G. Wilke *et al.*, *Angew. Chem. Int. Ed.* **5**, 151 (1966); M. F. Semmelhack in *Organic Reactions* vol. 19 (Wiley, New York, 1972) p 115; E. J. Corey, H. A. Kirst, *J. Am. Chem. Soc.* **94**, 667 (1972). Kinetic studies: D. H. Stedman *et al.*, *Science* **208**, 1029 (1980). Toxicity study: Hackett, Sunderman, *Arch. Environ. Health* **14**, 604 (1967). Review: Nicholls in *Comprehensive Inorganic Chemistry* vol. 3, J. C. Bailar, Jr. *et al.*, Eds. (Pergamon Press, Oxford, 1973) pp 1115-1119.

Colorless, volatile liquid. *Poisonous!* Oxidizes in the air: explodes at about 60°.  $d^{17}_4$  1.318. bp 43°. mp -19.3°. Crit temp about 200°. Crit pressure about 30 atm. Sol in about 5000 parts water free from air; sol in alcohol, benzene, chloroform, acetone, carbon tetrachloride. LD<sub>50</sub> in rats (mg/kg): 39 i.p.; 63 s.c.; 66 i.v. (Hackett, Sunderman).

**Caution:** Potential symptoms of overexposure are headache, vertigo; nausea, vomiting, epigastric pain; substernal pain; cough, hyperpnea; cyanosis; weakness; leukocytosis; pneumonitis; delirium; convulsions. See *NIOSH Pocket Guide to Chemical Hazards* (DHHS/NIOSH 97-140, 1997) p 222. See also *Clinical Toxicology of Commercial Products*, R. E. Gosselin *et al.*, Eds. (Williams & Wilkins, Baltimore, 5th ed., 1984) Section II, p. 145. This substance is reasonably anticipated to be a human carcinogen: *Ninth Report on Carcinogens* (PB2000-107509, 2000) p III-155.

**USE:** In organic synthesis; production of high-purity nickel powder and continuous nickel coatings on steel and other metals.

**6529. Nickel Chloride.** [7718-54-9] Nickel dichloride.  $Cl_2Ni$ ; mol wt 129.60. Cl 54.71%, Ni 45.29%.  $NiCl_2$ . Evalu-

ation of carcinogenic risk: *IARC Monographs* **49**, 257-445 (1990).

Yellow deliquescent scales. Soly in water (g/l): 642 (20°), 876 (100°). Sol in ethanol, ammonium hydroxide. Insol in nitric acid. Sublimable in absence of air and readily absorbs  $NH_3$ . The aq soln is acid; pH about 4. *Keep well closed.* LD<sub>50</sub> in mice, rats (mg/kg): 48, 11 i.p. (IARC).

**Hexahydrate.** [7791-20-0] Green, deliquescent crystals or cryst powder. Monoclinic. Structure reported to be *trans*- $[NiCl_2(H_2O)_4] \cdot 2H_2O$ : Mizuno, *J. Phys. Soc. Japan* **16**, 1574 (1960), *C.A.* **55**, 26605g (1961). Sol in about one part water, in alcohol.

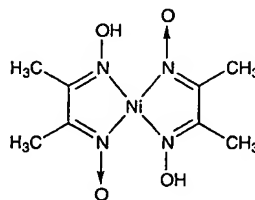
**USE:** Anhydr salt as absorbent for  $NH_3$  in gas masks. Hexahydrate for nickel electroplating; manuf nickel catalysts.

**6530. Nickel Cyanide.** [557-19-7]  $C_2N_2Ni$ ; mol wt 110.73. C 21.69%, N 25.30%, Ni 53.01%.  $Ni(CN)_2$ . Prepn of yellow-brown anhydr salt: Aynsley, Campbell, *J. Chem. Soc.* **1958**, 1723. (The commercial salt usually contains 20-25% water.)

**Tetrahydrate.** Apple-green powder. *Poison!* Insol in water. Slightly sol in dil acids, freely in alkali cyanides, in ammonia, and in ammonium carbonate.

**USE:** In nickel-plating.

**6531. Nickel Dimethylglyoxime.** [13478-93-8] Bis[(2,3-butanedione dioximato)(1-)-*N,N'*]nickel; bis(dimethylglyoximate)nickel.  $C_8H_{14}N_4NiO_4$ ; mol wt 288.91. C 33.26%, H 4.88%, N 19.39%, Ni 20.32%, O 22.15%. Prepn: Banks *et al.*, *J. Am. Chem. Soc.* **77**, 324 (1955); F. J. Welcher, *Organic Analytical Reagents* vol. 3 (Van Nostrand, New York, 1947) pp 165-179; Thabet *et al.*, *Inorg. Nucl. Chem. Letters* **8**, 211 (1972). Structure: Godycki, Rundle, *Acta Cryst.* **6**, 487 (1953); Merritt, *Anal. Chem.* **25**, 718 (1953).



Scarlet-red, cryst powder. Sublimes at 250°. Insol in water, acetic acid, ammonia. Sol in dil mineral acids and appreciably sol in abs alcohol.

**USE:** As sun-fast pigment in paints, lacquers, cellulose compounds and cosmetics.

**6532. Nickel Fluoride.** [10028-18-9] Nickel difluoride; nickelous fluoride.  $F_2Ni$ ; mol wt 96.69. F 39.30%, Ni 60.70%.  $NiF_2$ . Prepn: Henkel, Klemm, *Z. Anorg. Allgem. Chem.* **222**, 74 (1935); Priest, *Inorg. Syn.* **3**, 173 (1950); Rochow, Kukin, *J. Am. Chem. Soc.* **74**, 1615 (1952); Haendler *et al.*, *ibid.* **3167**. Book: *Medical and Biological Effects of Environmental Pollutants: Nickel* (National Acad. Sci., Washington DC, 1975) 277 pp.

Yellowish to green tetragonal crystals (rutile type).  $d$  4.72. Sublimes in HF stream above 1000°. Slightly sol in water (4 g/100 ml at 25°). Aq solns are dec by boiling. Insol in alcohol, ether. LD<sub>50</sub> i.v. in mice: 130 mg/kg (Nat. Acad. Sci.).

**Caution:** Chronic exposure may cause mottling of teeth, changes in bones.

**6533. Nickel Formate.** [3349-06-2]  $C_2H_2NiO_4$ ; mol wt 148.73. C 16.15%, H 1.36%, Ni 39.46%, O 43.03%.  $Ni(HCOO)_2$ . Prepd by reaction of formic acid with Ni: Johnson, *US 2576072* (1951 to Harshaw Chemical); with  $NiCO_3$ : Bircumshaw, Edwards, *J. Chem. Soc.* **1950**, 1800.

**Dihydrate.** Fine, green, monoclinic crystals. Becomes anhydr on careful heating to 130-140°; decomposes at 180-200° yielding Ni, CO,  $CO_2$ ,  $H_2$ ,  $H_2O$ ,  $CH_4$ .  $d^{20}_4$  2.154. Moderately sol in water. Practically insol in alc, formic acid.

**USE:** Manuf of Ni; prepn of Ni catalysts for organic reactions, particularly hydrogenation catalysts.

**6534. Ni oxide.**  $H_2N$  34.51%.  $Ni(C$  **Monohydr** to form  $NiO$  : monia.

**Note:** This carcinogen: *1* 2000) p III-15

**6535. Ni** mol wt 312.5( Iron-black ( bluish-green vcohol. *Keep* )

**6536. Ni** nickel protoxi Occurs as the Green powe **Note:** This carcinogen: *1* 2000) p III-15 **USE:** Paint;

**6537. Ni** 182.70. N 15. **Hexahydra** bp 137°. Sol i pH about 4. *1* H. F. Smyth *e* **USE:** Nicke

**6538. Ni** 146.71. C 16. Dihydrate, l acids, in solns

**6539. Ni** 366.02. Ni 48 **Octahydrate** ammonia. **USE:** On ig oil and water (

**6540. Ni** black nickel ( 29.02%. Cont Gray-black j sol in water; v with evolution of oxygen.

**6541. Ni** 154.75. Ni 37 icity data: E. *1* Evaluation of 445 (1990); *T* 454, NIH 96-3

**Hexahydrat** blue to blue-g 53.3°.  $\beta$ -Form comes blue an somewhat eff yellow anhydr ingly sol in alc ~4.5. LD<sub>50</sub> in gan).

**Heptahydra** ethanol. **USE:** In nic fabrics; blacke

**6542. Nic** tro[1,1'-biphen phenol; 5,5'-di chloropholan; B;  $O_4$ ; mol wt 34; O 27.82%. A

**2466. Cobaltous Formate.** [544-18-3]  $C_2H_2CoO_4$ ; mol wt 148.97. C 16.12%, H 1.35%, Co 39.56%, O 42.96%.  $Co(HCOO)_2$ . Prepn: *Gmelin's, Cobalt* (8th ed.) 58 (part A), 350 (1932) and supplement, 702 (1961).

**Dihydrate.** Red, cryst powder.  $d_4^{25}$  2.13. Sol in water; almost insol in alcohol. Becomes anhydr at 140°.

USE: In prepn of Co catalysts.

**2467. Cobaltous Hydroxide.** [21041-93-0]  $CoH_2O_2$ ; mol wt 92.95. Co 63.40%, H 2.17%, O 34.43%.  $Co(OH)_2$ . Prepd from a solution of a cobaltous salt and an alkali hydroxide: Glemser in *Handbook of Preparative Inorganic Chemistry*, vol. 2, G. Brauer, Ed. (Academic Press, New York, 2nd ed., 1965) p 1521; Weiser, Milligan, *J. Phys. Chem.* 36, 722 (1932). Review: de Bie, Doyen, *Cobalt* 15, 3-13; 16, 3-15 (1962).

Blue-green or rose-red powder or microscopic rhombohedral crystals; red form is the more stable of the two.  $d_4^{25}$  3.597. Easily oxidized by air or weak oxidizing agents to  $Co(OH)_3$ . Amphoteric. Loses water on heating, forming  $CoO$  at 168° in *vacuo*. Very slightly sol in water; readily sol in acids; practically insol in dil alkalis; sol in ammonia.

USE: Manuf of Co compds; drier for paints; in enhancing drying properties of lithographic printing inks; in storage battery electrode impregnating solns.

**2468. Cobaltous Iodide.** [15238-00-3] Cobalt diiodide.  $CoI_2$ ; mol wt 312.74. Co 18.84%, I 81.16%. Prepn: Clark, Buchner, *J. Am. Chem. Soc.* 44, 230 (1922); Chaigneau, *Bull. Soc. Chim. France* 1957, 886; Chaigneau, Chastagnier, *ibid.* 1958, 1192; Glemser in *Handbook of Preparative Inorganic Chemistry*, vol. 2, G. Brauer, Ed. (Academic Press, New York, 2nd ed., 1965) p 1518.

The anhydr salt exists in two isomorphous forms.  $\alpha$ - $CoI_2$ : black, graphite-like solid. mp 515-520° (in high vacuum).  $d_4^{25}$  5.584. Very hygroscopic, becomes blackish-green in air. Sol in water to give pink to red soln.  $\beta$ - $CoI_2$ : ochre-yellow powder. Blackens at 400° and converts to  $\alpha$ -form.  $d_4^{25}$  5.45. Very hygroscopic; deliquesces in moist air forming green droplets. Sol in water to give colorless soln which becomes pink on heating.

**Hexahydrate.** Dark red hexagonal prisms. Loses  $H_2O$  on heating becoming anhydr by 130°. d 2.90. Loses  $I_2$  on exposure to air and light. Sol in water to give soln which is red below 20°, olive green at 20 to 40°, and green at higher temps. Sol in ethanol (blue soln), ether (blue to green soln), chloroform (blue soln), acetone.

USE: Indicator for moisture and humidity; determination of water in organic solvents; catalyst for organic reactions.

**2469. Cobaltous Nitrate.** [10141-05-6]  $CoN_2O_6$ ; mol wt 182.94. Co 32.21%, N 15.31%, O 52.47%.  $Co(NO_3)_2$ . Prepn: *Gmelin's, Cobalt* (8th ed.) 58 (part A), 252-262 (1932) and supplement, 515-521 (1961); Weigel *et al.*, *Bull. Soc. Chim. France* 1964, 836; Addison, Sutton, *J. Chem. Soc.* 1964, 5553. Toxicity study: G. J. A. Speijers *et al.*, *Food Chem. Toxicol.* 20, 311 (1982). Review of toxicology: B. Venugopal, T. D. Luckey, *Environ. Qual. Safety Suppl.* 1, 4-73 (1975). Review: de Bie, Doyen, *Cobalt* 15, 3-13; 16, 3-15 (1962).

Pale red powder. Dec at 100-105°. d 2.49. Sol in water. LD in rabbits (mg/kg): 250 orally, 75 s.c. (Venugopal, Luckey).

**Hexahydrate.** [10026-22-9] Red, deliquescent, monoclinic crystals. mp ~55°. Red liq becomes green and dec to the oxide above 74°. d 1.88. Very sol in water, alcohol, most organic solvents. *Keep well closed in a cool place.* LD<sub>50</sub> orally in rats: 691 mg/kg (Speijers).

USE: Manuf of cobalt pigments and invisible inks; decorating stoneware and porcelain; prepn of catalysts; production of vitamin B<sub>12</sub> supplements.

**2470. Cobaltous Oxalate.** [814-89-1]  $C_2CoO_4$ ; mol wt 146.95. C 16.35%, Co 40.10%, O 43.55%.  $CoC_2O_4$ . Prepn: Robin, *Bull. Soc. Chim. France* 1953, 1078; *Gmelin's, Cobalt* (8th ed.) 58 (part A) p 355 (1932) and supplement, pp 704-706 (1961). Review: de Bie, Doyen, *Cobalt* 15, 3-13; 16, 3-15 (1962).

$d_4^{25}$  3.021. Readily absorbs moisture from air to form hydrates.

**Dihydrate.** Light pink microcryst powder or needles. Almost insol in water; slightly sol in acids; almost insol in aq

oxalic acid; freely sol in aq ammonia. Dec on heating with aq KOH or  $Na_2CO_3$  soln.

**Tetrahydrate.** Yellowish-pink amorphous powder. Effloresces on exposure to air. Loses water on heating to 100° giving the dihydrate. Very slightly sol in water; slightly sol in acids; readily sol in aq ammonia.

USE: Prepn of Co catalysts, Co metal powder for powder-metallurgical applications; stabilizer for HCN; temperature indicator.

**2471. Cobaltous Oxide.** [1307-96-6]  $CoO$ ; mol wt 74.93. Co 78.65%, O 21.35%. Prepn: Amiel *et al.*, *Compt. Rend.* 259, 3512 (1964); Wilke, *Z. Anorg. Allgem. Chem.* 330, 164 (1964). Toxicity study: Smyth *et al.*, *Am. Ind. Hyg. Assoc. J.* 30, 470 (1969). Review: de Bie, Doyen, *Cobalt* 15, 3-13; 16, 3-15 (1962).

Powder, or cubic or hexagonal crystals. Color varies from olive green to red, depending on the particle size, but the commercial material is usually dark grey and contains about 76% Co. mp ~1935°. d 5.7 to 6.7, depending on method of prepn. Readily absorbs  $O_2$  even at room temp. Practically insol in water. Sol in acids or alkalies. Easily reduced to Co by C or CO. Reacts at high temperatures with silica, alumina, zinc oxide to form pigments. LD<sub>50</sub> orally in rats: 1.70 g/kg (Smyth).

Note: The commercial oxides are usually not definite chemical compds but mixtures of the cobalt oxides.

USE: In pigments for ceramics; glass coloring and decolorization; oxidation catalyst for drying oils, fast-drying paints and varnishes; prepn of cobalt-metal catalysts, Co powder for binder in sintered tungsten carbide; in semiconductors.

**2472. Cobaltous Phosphate.** [13455-36-2] C.I. Pigment Violet 14; C.I. 77360.  $Co_3O_8P_2$ ; mol wt 366.74. Co 48.21%, O 34.90%, P 16.89%.  $Co_3(PO_4)_2$ . Prepn from  $CoCl_2$  and  $(NH_4)_2HPO_4$ : Klement, Haselbeck, *Z. Anorg. Allgem. Chem.* 334, 27 (1964); from  $Ca(H_2PO_4)_2$ : Vickery, US 2914380 (1959 to Horizons). Review: de Bie, Doyen, *Cobalt* 15, 3-13; 16, 3-15 (1962). See also *Colour Index* vol. 4 (3rd ed., 1971) p 4665.

**Octahydrate.** Pink to lavender amorph powder. d 2.77. Practically insol in water; sol in mineral acids.

USE: In ceramic pigments; in artists' colors, plastic resins.

**2473. Cobaltous Sulfate.** [10124-43-3]  $CoO_4S$ ; mol wt 154.99. Co 38.02%, O 41.29%, S 20.69%.  $CoSO_4$ . Hexahydrate occurs in nature as the mineral *bieberite*. Prepn: Clark *et al.*, *J. Am. Chem. Soc.* 42, 2483 (1920); Hammel, *Ann. Chim.* 11, 247 (1939); *Gmelin's, Cobalt* (8th ed.) 58, (part A) 324-336 (1932) and supplement, 628-647 (1961). Review: de Bie, Doyen, *Cobalt* 15, 3-13; 16, 3-15 (1962).

Red to lavender dimorphic, orthorhombic crystals.  $d_4^{25}$  3.71. Stable to 708°. Dissolves slowly in boiling water.

**Monohydrate.** Rose-colored, monoclinic crystals. Structure reported to be  $Co(H_2SO_5)$ .  $d_4^{25}$  3.08. Dissolves slowly in boiling water.

**Heptahydrate.** Structure reported to be  $[Co(H_2O)_6][H_2SO_5]$ . Pink to red monoclinic, prismatic crystals. On heating dehydrates to the hexahydrate (monoclinic, prismatic crystals) at 41.5°, and to the monohydrate at 71°.  $d_4^{25}$  2.03. Sol in water; slightly sol in methanol, ethanol.

USE: Usual source of water-soluble cobalt since it is the most economical and it shows less tendency to deliquesce or dehydrate than the chloride or nitrate. Used in storage batteries; in Co-electroplating baths; as drier for lithographic inks, varnishes; in ceramics, enamels, glazes to prevent discoloring; in Co pigments for decorating porcelain.

**2474. Cobaltous Sulfide.** [1317-42-6]  $CoS$ ; mol wt 91.00. Co 64.76%, S 35.24%. Prepn: Glemser in *Handbook of Preparative Inorganic Chemistry*, vol. 2, G. Brauer, Ed. (Academic Press, New York, 2nd ed., 1965) p 1523.

Exists in two forms.  $\alpha$ - $CoS$ : black, amorphous powder. Forms  $Co(OH)S$  in air. Sol in HCl.  $\beta$ - $CoS$ : grey powder or reddish-silver octahedral crystals. mp >1100°; d 5.45. Practically insol in water; sol in acids.

USE: Catalyst for hydrogenation or hydrodesulfurization.

**2475. Cobaltous Thiocyanate.** [3017-60-5] Cobaltous rhodanide; cobaltous sulfocyanate.  $C_2CoN_2S_2$ ; mol wt 175.10.

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**6534. Nickel Hydroxide.** [12054-48-7] "Green nickel oxide".  $\text{H}_2\text{NiO}_2$ ; mol wt 92.71. H 2.17%, Ni 63.31%, O 34.51%.  $\text{Ni}(\text{OH})_2$ .

**Monohydrate.** Apple-green powder. Decomp above  $200^\circ$  to form  $\text{NiO}$  and  $\text{H}_2\text{O}$ . Insol in water. Sol in dil acids, in ammonia.

**Note:** This substance is reasonably anticipated to be a human carcinogen: *Ninth Report on Carcinogens* (PB2000-107509, 2000) p III-155.

**6535. Nickel Iodide.** [13462-90-3] Nickel diiodide.  $\text{I}_2\text{Ni}$ ; mol wt 312.50. I 81.22%, Ni 18.78%.  $\text{NiI}_2$ .

Iron-black color. Sublimes in absence of air. Hexahydrate, bluish-green very deliquescent crystals. Very sol in water or alcohol. *Keep well closed.*

**6536. Nickel Monoxide.** [1313-99-1] Nickellous oxide; nickel protoxide.  $\text{NiO}$ ; mol wt 74.69. Ni 78.58%, O 21.42%. Occurs as the mineral *bunsenite*.

Green powder; yellow when hot. Insol in water. Sol in acids.

**Note:** This substance is reasonably anticipated to be a human carcinogen: *Ninth Report on Carcinogens* (PB2000-107509, 2000) p III-155.

**USE:** Painting on porcelain.

**6537. Nickel Nitrate.** [13138-45-9]  $\text{N}_2\text{NiO}_6$ ; mol wt 182.70. N 15.33%, Ni 32.13%, O 52.54%.  $\text{Ni}(\text{NO}_3)_2$ .

**Hexahydrate.** Green, deliquescent crystals. d 2.05. mp  $56.7^\circ$ . bp  $137^\circ$ . Sol in 0.4 part water, in alcohol. The aq soln is acid; pH about 4. *Keep well closed.* LD<sub>50</sub> orally in rats: 1.62 g/kg, H. F. Smyth *et al.*, *Am. Ind. Hyg. Assoc. J.* 30, 470 (1969).

**USE:** Nickel-plating; manuf brown ceramic colors.

**6538. Nickel Oxalate.** [547-67-1]  $\text{C}_2\text{NiO}_4$ ; mol wt 146.71. C 16.37%, Ni 40.01%, O 43.62%.  $\text{NiC}_2\text{O}_4$ .

Dihydrate, light green powder. Insol in water; sol in mineral acids, in solns of ammonium chloride, nitrate, or sulfate.

**6539. Nickel Phosphate.** [10381-36-9]  $\text{Ni}_3\text{O}_8\text{P}_2$ ; mol wt 366.02. Ni 48.11%, O 34.97%, P 16.92%.  $\text{Ni}_3(\text{PO}_4)_2$ .

Octahydrate, light green powder. Insol in water; sol in acids, ammonia.

**USE:** On ignition yields "nickel yellow"—a pigment used in oil and water colors.

**6540. Nickel Sesquioxide.** [1314-06-3] Nickelic oxide; black nickel oxide.  $\text{Ni}_2\text{O}_3$ ; mol wt 165.39. Ni 70.98%, O 29.02%. Contains a variable quantity of water.

Gray-black powder. Dec at  $\sim 600^\circ$  into  $\text{NiO}$  and oxygen. Insol in water; very slightly sol in cold acid; dissolved by hot HCl with evolution of Cl, and by hot  $\text{H}_2\text{SO}_4$  or  $\text{HNO}_3$  with evolution of oxygen.

**6541. Nickel Sulfate.** [7786-81-4]  $\text{NiO}_4\text{S}$ ; mol wt 154.75. Ni 37.93%, O 41.35%, S 20.72%.  $\text{NiSO}_4$ . Acute toxicity data: E. L. Reagan, *J. Am. Coll. Toxicol.* 1, 685 (1992). Evaluation of carcinogenic risk: *IARC Monographs* 49, 257-445 (1990); *Toxicology and Carcinogenesis Studies* (NTP TR-454, NIH 96-3370, 1996) 379 pp.

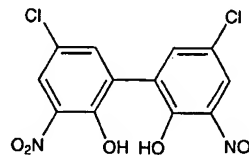
**Hexahydrate.** [10101-97-0] Two known phases.  $\alpha$ -Form, blue to blue-green tetragonal crystals; transition to  $\beta$ -form at  $53.3^\circ$ .  $\beta$ -Form, green transparent crystals; stable at  $40^\circ$ ; becomes blue and opaque at room temp. Sweet astringent taste; somewhat efflorescent. Loses  $5\text{H}_2\text{O}$  at  $\sim 100^\circ$ . Greenish-yellow anhydrous salt formed at  $280^\circ$ . Sol in 1.4 parts water; sparingly sol in alcohol, more in methanol. The aq soln is acid; pH  $\sim 4.5$ . LD<sub>50</sub> in male, female rats (mg/kg): 335, 264 orally (Reagan).

**Heptahydrate.** [10101-98-1] Green crystals. Sol in water, ethanol.

**USE:** In nickel-plating; as mordant in dyeing and printing fabrics; blackening zinc and brass.

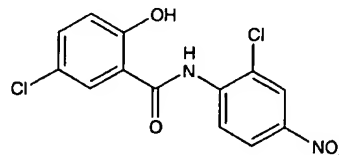
**6542. Niclofolan.** [10331-57-4] 5,5'-Dichloro-3,3'-dinitro[1,1'-biphenyl]-2,2'-diol; 4,4'-dichloro-6,6'-dinitro-*o,o'*-biphenol; 5,5'-dichloro-2,2'-dihydroxy-3,3'-dinitrobiphenyl; menichlopholan; Bayer 9015; ME-3625; Bilevon-M.  $\text{C}_{12}\text{H}_6\text{Cl}_2\text{N}_2\text{O}_6$ ; mol wt 345.09. C 41.77%, H 1.75%, Cl 20.55%, N 8.12%, O 27.82%. Anthelmintic activity: Meiser, Federmann, US

3082151 (1963 to Bayer); P. J. Lane, J. M. Stewart, *Vet. Rec.* 80, 702 (1967). Pharmacokinetics in desert sheep: B. H. Ali *et al.*, *J. Vet. Pharmacol. Ther.* 13, 217 (1990).



**THERAP CAT (VET):** Anthelmintic (fasciolicide).

**6543. Niclosamide.** [50-65-7] 5-Chloro-*N*-(2-chloro-4-nitrophenyl)-2-hydroxybenzamide; 2',5-dichloro-4'-nitrosalicylanilide; 5-chloro-*N*-(2'-chloro-4'-nitrophenyl)salicylamide; 5-chlorosalicyloyl-(*o*-chloro-*p*-nitranilide); *N*-(2'-chloro-4'-nitrophenyl)-5-chlorosalicylamide; Bayer 2353; Cestocide; Niclo-cide; Ruby; Trédémine; Yomesan.  $\text{C}_{13}\text{H}_8\text{Cl}_2\text{N}_2\text{O}_4$ ; mol wt 327.12. C 47.73%, H 2.47%, Cl 21.68%, N 8.56%, O 19.56%. Prepn: **GB 824345** (1959 to Bayer), *C.A.* 54, 15822b (1960). *See also:* E. Schraufstätter, R. Gönner, **US 3079297**; R. Strufe *et al.*, **US 3113067** (both 1963 to Bayer); Bekhli *et al.*, *Med. Prom. SSSR* 1965, 25.



Pale yellow crystals, mp  $225-230^\circ$ . Practically insol in water. Sparingly sol in ethanol, chloroform, ether.

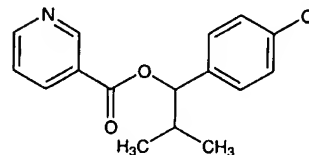
**Ethanolamine salt.** [1420-04-8] Clonitride; Bayluscid.  $\text{C}_{13}\text{H}_8\text{Cl}_2\text{N}_2\text{O}_4 \cdot \text{C}_2\text{H}_7\text{NO}$ ; mol wt 388.21. Yellow-brown solid, mp  $204^\circ$ .

**USE:** The ethanolamine salt as a molluscicide.

**THERAP CAT:** Anthelmintic (Cestodes).

**THERAP CAT (VET):** Anthelmintic (Cestodes).

**6544. Nicoclonate.** [10571-59-2] 3-Pyridinecarboxylic acid 1-(4-chlorophenyl)-2-methylpropyl ester; nicotinic acid *p*-chloro- $\alpha$ -isopropylbenzyl ester; 1-(*p*-chlorophenyl)isobutyl nicotinate; *p*-chlorophenylisopropylcarbinol nicotinate; 1-(*p*-chlorophenyl)-1-(nicotinoyloxy)-2-methylpropane; S-486; Lipidium.  $\text{C}_{16}\text{H}_{16}\text{ClNO}_2$ ; mol wt 289.76. C 66.32%, H 5.57%, Cl 12.24%, N 4.83%, O 11.04%. Prepn: J. Nordmann, H. B. Swierkot, **FR M3454**; *idem*, **US 3367939** (1965, 1968 both to Kuhlmann).



Base, white needles from methanol and water, mp  $61-62^\circ$  (Maquenne block);  $55-56.5^\circ$  (Culatti block). Very soluble in lipids; sol in alcohols, benzene, toluene, ether and acetone. Practically insol in water.

**Hydrochloride.**  $\text{C}_{16}\text{H}_{17}\text{Cl}_2\text{NO}_2$ . Crystals from methanol, mp  $124-127^\circ\text{C}$ . LD<sub>50</sub> i.p. in mice: 2.27 g/kg (Nordmann, Swierkot).

**THERAP CAT:** Antilipemic.

**6545. Nicofuranose.** [15351-13-0]  $\beta$ -D-Fructofuranose 1,3,4,6-tetra-3-pyridinecarboxylate; fructose 1,3,4,6-tetranicotinate; 1,3,4,6-tetranicotinoylfructofuranose; 1,3,4,6-tetranicotinoyl-D-fructose; Vasperdil; Bradilan.  $\text{C}_{30}\text{H}_{24}\text{N}_4\text{O}_{10}$ ; mol wt